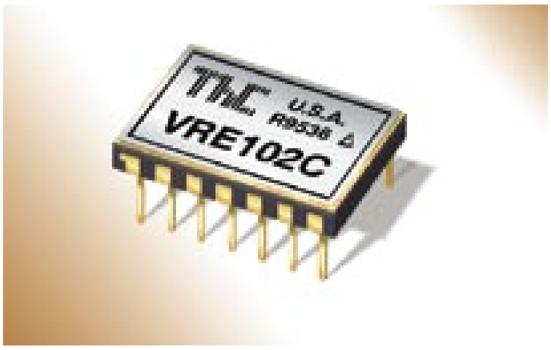
0.3-0.8ppm/˚C Precision zener-based references



Theory of operation

The following refers to the schematic. In operation, approximately 6.3 volts is applied to the noninverting input of the op amp. The voltage is amplified by the op amp to produce a 10.000V output. The gain is determined by the networks R1 and R2: G=1 + R2/R1. The 6.3V zener diode is used because it is the most stable diode over time and temperature.

The zener operating current is derived from the regulated output voltage through R3. This feedback arrangement provides a closely regulated zener current. This current determines the slope of the references' voltage vs. temperature function. By trimming the zener current a lower drift over temperature can be achieved. But since the voltage vs. temperature function is nonlinear this compensation technique is not well suited for wide temperature ranges.

A specially developed nonlinear compensation network of thermistors and resistors is used in the VRE series voltage references. This proprietary network eliminates most of the nonlinearity in the voltage vs. temperature function. By then adjusting the slope, a very stable voltage over wide temperature ranges is produced.

This network is less than two per cent of the overall network resistance so it has a negligible effect on long term stability. By using highly stable resistors in the network a voltage reference with very good long term stability is produced .

Application information

When trimming the VRE102, the positive voltage should be trimmed first since the negative voltage tracks the positive side. Pay careful attention to the circuit layout to avoid noise pickup and voltage drops in the lines.

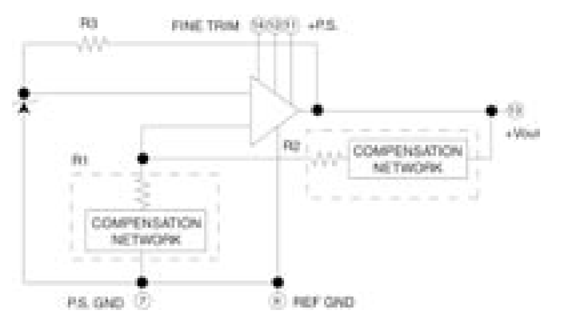
The VRE100 series voltage references have the ground terminal brought out on two pins (pin 6 and pin 7) which are connected together internally. This allows the user to achieve greater accuracy when using a socket.

Voltage references have a voltage drop across their power supply ground pin due to quiescent current flowing through the contact resistance. If the contact resistance was constant with time and temperature, this voltage drop could be trimmed out.

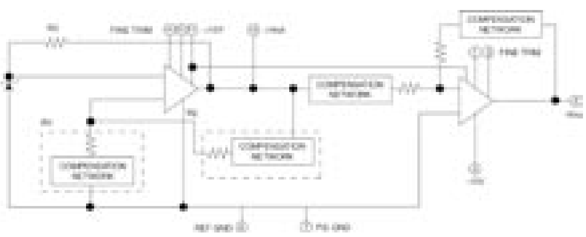
When the reference is plugged into a socket, this source of error can be as high as 20ppm. By connecting pin 7 to the power supply ground and pin 6 to a high impedance ground point in the measurement circuit, the error due to the contact resistance can be eliminated. If the unit is soldered into place the contact resistance is sufficiently small that it doesn't affect performance.

The VRE100 series voltage references can be connected with or without the use of pin 6 and still provide performance superior to the AD2700 and AD2710 series voltage references.

VRE100/300



VRE102



Voltage references – cross reference guide

Having a difficult time finding voltage references?

Use our cross reference guide to find a replacement part. Typically our voltage references offer superior electrical characteristics over competitors' references, especially with regard to temperature co-efficient and initial error.

Military processing and packaging is available on some models – please contact us for details.

Other manufacturer	Thaler part	Package replacement	Exact option	Military
AD2700	VRE100	DIP14	*	*
AD2701	VRE101	DIP14	*	
AD2702	VRE102	DIP14	*	*
AD2710	VRE102	DIP14	*	*
AD586	VRE305	DIP8, SMT8	*	
AD587	VRE310	DIP8, SMT8	*	
AD680	VRE302	DIP8, SMT8	*	
ADR290	VRE4120	SOIC8	*	
ADR291	VRE4125	SOIC8	*	
ADR292	VRE4141	SOIC8	*	
CS3902	VRE104	DIP14	*	*
LT1021-10	VRE310	DIP8, SMT8	*	
LT1021-5	VRE305	DIP8, SMT8	*	
LT1027	VRE305	DIP8, SMT8	*	
LT1236-10	VRE310	DIP8, SMT8	*	
LT1236-5	VRE305	DIP8, SMT8	*	
LT1460-2.5	VRE4125	SOIC8	*	
LT1461-2.5	VRE4125	SOIC8	*	
LT1461-4	VRE4141	SOIC8	*	
LTC1798-2.5	VRE4125	SOIC8	*	
LTC1798-4.1	VRE4125	SOIC8	*	
MAX6161	VRE4112	SOIC8	*	
MAX6162	VRE4120	SOIC8	*	
MAX6164	VRE4141	SOIC8	*	
MAX6166	VRE4125	SOIC8	*	
MAX6190	VRE4112	SOIC8	*	
MAX6191	VRE4121	SOIC8	*	
MAX6198	VRE4141	SOIC8	*	
MAX674	VRE310	DIP8, SMT8	*	
MAX675	VRE305	DIP8, SMT8	*	
MC1404-10	VRE310	DIP8, SMT8	*	
MC1404-5	VRE305	DIP8, SMT8	*	
REF01	VRE210	LCC20	*	*
REF01	VRE310	DIP8, SMT8	*	
REF02	VRE205	LCC20	*	*
REF02	VRE305	DIP8, SMT8	*	
REF03	VRE302	DIP8, SMT8	*	
REF102	VRE310	DIP8, SMT8	*	
REF191	VRE4120	SOIC8	*	
REF192	VRE4125	SOIC8	*	
REF198	VRE4141	SOIC8	*	

The use of a precision voltage reference circuit (continued)

for 14-bit and 16-bit A/D and D/A converters

This application note covers issues concerning the performance and design of a complete precision voltage reference circuit consisting of the VRE3050 precision reference, the MAX1682 charge pump voltage doubler, and the THS1265 (Texas Instruments, 12-bit IF sampling communications A/D convertor) evaluation board. The MAX1682 provides a stable +10V to the VRE3050 reference. The output from the VRE3050 is divided down to provide a 2V differential signal to the THS1265 converter.

The system is designed to provide an adjustable external precision voltage reference, to minimise voltage drift, to operate over the commercial (0˚C to +70˚C) or industrial (-40˚C to +85˚C) temperature range and an adjustable external voltage reference to 12-bit, 14-bit and 16-bit communication data converters.

High resolution analogue-to-digital (A/D) and digital-to-analogue (D/A) converters rely on the use of an external precision voltage reference to establish absolute measurement accuracy. Any reference error undermines the overall system accuracy. Thus the external voltage reference must provide an accurately set constant voltage, independent of load changes, temperature, input supply voltage and time. This practical circuit allows Vref+ and Vref- to be set precisely for the full scale setting of the converter.

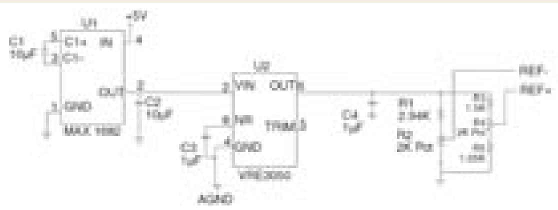
The circuitry

The complete external voltage reference circuit is shown in figure 1. Designed for simplicity, the circuit is comprised of a 2x charge pump (MAX1682), a precision voltage reference (VRE3050), and an adjustable resistor divider. The circuit was evaluated on the THS1265 evaluation board.

The MAX1682 is suitable for use in low voltage, low current applications where power management is of concern. The MAX1682 can deliver 30mA of output current with a voltage drop of only 600mV.

The device output appears at pin 2 of U1. See figure 1 for an input of +5V DC the chip's output is +10V DC. Capacitors C1 and C2 need some consideration. The values need to be large enough to reduce noise at both the input and output of the device. A 10uF capacitor was used in the circuit. Capacitor C2 must be rated for >10V.

Figure 1 – A practical adjustable voltage ref. circuit for 12, 14 & 16-bit data converters



The MAX1682 output is used to supply the DC input voltage required by the VRE3050. Capacitor C3, connected to U2 pin 8 is recommended for high frequency (10Hz-10kHz) noise reduction. The VRE3050 has a low 3mVp-p noise at 0.1-10Hz. Capacitor C4 was added to the VRE3050 output pin to reduce the high frequency system noise at the input to the THS1265.

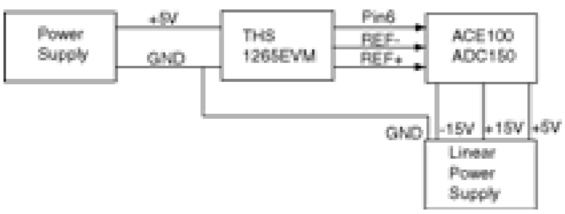
The new generation of A/D and D/A converters requires an external Vref ranging from 1.2V to 3.5V. The common voltage references available on the market are 1.2V, 2.5V, 4.096V and 5V. Intermediate voltages are often generated from a standard reference voltage using resistor networks. The resistors used are surface mount chip resistors that have a one per cent tolerance and a TC of 100ppm/˚C. In this design we wanted to make the Vref adjustable so we also included potentiometers.

Potentiometers R2 and R4 are used to set REF- and REF+ voltages, respectively. The potentiometer's TC will affect the value of both REF+ and REF- and therefore the potentiometers must be chosen from the same series and manufacturer. The TC of the potentiometers used in this circuit is specified at 100ppm/˚C maximum.

Test setup

The PCB used to evaluate the reference circuit is constructed from FR4 material with separate layers for power and ground planes. The power plane layer is split into an analog and a digital power section and the ground plane layer is also split into an analog and a digital ground section. Both analog and digital grounds are tied together at one single point on the ground plane layer. This helps to minimise switching noise interactions between the digital and analog circuits on the THS1265 EVM.

Figure 2 – Test setup



The measurement circuit for the voltages, setup and adapting of the THS1265 evaluation module PCB is shown in figure 2.

The THS1265 evaluation board was connected to a DC power supply then placed in a temperature controlled oven (+/-0.5˚C). A Thaler ACE100/ADC150 24 bit A/D evaluation board was used to monitor the voltage on pin 6 of the VRE3050 reference and pins REF- and REF+ on the THS1265 board. The grounds were tied to a common point to minimise ground loops. The oven was programmed for the commercial temperature range with data collection points at 70˚C, 25˚C, and 0˚C and the industrial temperature range with data collection points at 85˚C, 25˚C, -40˚C. The data was collected and stored to a file for analysis.

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